



## Using Apex To Construct CPM-GOMS Models

Models of human/computer interaction are generated automatically from descriptions of tasks.

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A process for automatically generating computational models of human/computer interactions as well as graphical and textual representations of the models has been built on the conceptual foundation of a method known in the art as CPM-GOMS. This method is so named because it combines (1) the task decomposition of analysis according to an underlying method known in the art as the goals, operators, methods, and selection (GOMS) method with (2) a model of human resource usage at the level of cognitive, perceptual, and motor (CPM) operations. CPM-GOMS models have made accurate predictions about behaviors of skilled computer users in routine tasks, but heretofore, such models have been generated in a tedious, error-prone manual process.

In the present process, CPM-GOMS models are generated automatically from a hierarchical task decomposition expressed by use of a computer program, known as Apex, designed previously to be used to model human behavior in complex, dynamic tasks. An inherent capability

of Apex for scheduling of resources automates the difficult task of interleaving the cognitive, perceptual, and motor resources that underlie common task operators (e.g., move and click mouse). The user interface of Apex automatically generates Program Evaluation Review Technique (PERT) charts, which enable modelers to visualize the complex parallel behavior represented by a model. Because interleaving and the generation of displays to aid visualization are automated, it is now feasible to construct arbitrarily long sequences of behaviors.

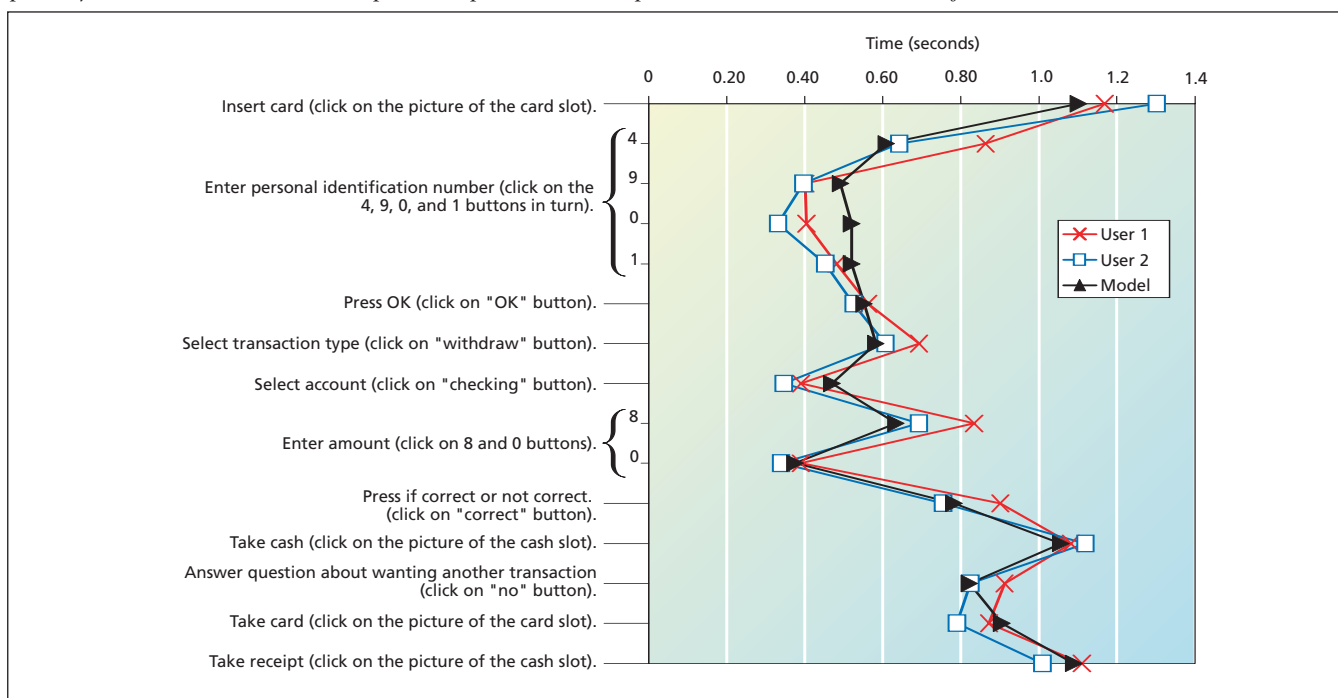
The process was tested by using Apex to create a CPM-GOMS model of a relatively simple human/computer-interaction task and comparing the time predictions of the model and measurements of the times taken by human users in performing the various steps of the task. The task was to withdraw \$80 in cash from an automated teller machine (ATM). For the test, a Visual Basic mockup of an ATM was created, with a provision for input from (and measure-

ment of the performance of) the user via a mouse.

The times predicted by the automatically generated model turned out to approximate the measured times fairly well (see figure). While these results are promising, there is need for further development of the process. Moreover, it will also be necessary to test other, more complex models: The actions required of the user in the ATM task are too sequential to involve substantial parallelism and interleaving and, hence, do not serve as an adequate test of the unique strength of CPM-GOMS models to accommodate parallelism and interleaving.

*This work was done by Bonnie John of Carnegie Mellon University and Alonso Vera, Michael Matessa, Michael Freed, and Roger Remington of Ames Research Center. Further information is contained in a TSP (see page 1).*

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Times Taken in the Various Steps of a simulated withdrawal of cash from an ATM were predicted by an automatically generated model and measured in sequences of 10 error-free trials of two users who had practiced the task.